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## NOTES ON SOME NEMATODES FROM FRESH-WATER FISHES \*

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The parasitic nematodes are of conspicuous importance in the field of human disease and also in diseases of the domestic animals, and in his treatise on fish diseases, Hofer (1906), discussing the significance in fish culture of parasites and parasitic diseases, states that among them the nematodes outrank all others in number of types. Yet as fish parasites these forms are almost unknown in North America, and references to them are confined to a few brief notes, almost all of which came from the pen of the distinguished Philadelphia microscopist, anatomist, and parasitologist, Joseph Leidy, whose pioneer work published between 1850 and 1886 includes many records of great value on this group.

In this little-explored field the senior author has been making observations for many years and in collaboration with the junior author was led recently to undertake an extended study of nematode parasites from North American fresh-water fishes which has yielded a number of new and interesting forms; these are briefly described here in advance of the appearance of the complete article in which will be given fuller data on the structure and relationships of these species. Especial thanks are due the United States Bureau of Fisheries for aid in securing material.

It is interesting to note that among the eight forms described as new species, three fall within new genera and five agree sufficiently with European forms to be listed in already existing genera. Seven out of the nine forms described in this paper come within the limits of the Spiruroidea, so that this superfamily appears to hold a prominent place among parasites of fresh-water fishes.

*Cystidicola* Fischer von Waldheim 1797. — The type species *C. farionis* from the air-bladder of the trout and other fishes is a common form in Europe; it has also been reported from the lake trout of Lake Erie. Leidy (1886) described a parasite of the air-bladder of the lake trout as *Filaria stigmatura*. We have the same parasite from the white fish, lake trout, and lake herring in Lake Erie, Lake St. Clair and Lake Michigan. It is clearly not a *Filaria*, but belongs to the genus *Cystidicola*, and should be called *C. stigmatura*. Two small

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uncinate lips, a short buccal capsule or tubular pharynx followed by a long esophagus divided into an anterior muscular and a posterior glandular region, indicate the position of this form in the superfamily Spiruroidea created by Railliet and Henry (1916) and in the family Camallanidae established by the same authors.

*Camallanus* Railliet and Henry 1915. — Among the commonest and best known parasites of fresh-water fish in Europe is the so-called Hooded Worm, easily recognized by its horny oral armature in the form of heavy ribbed valve-shaped lips of dark brown material with corner anchors of trident form. More than fifty names have been given these worms which most often have been assigned to the genera *Dacnitis* and *Cucullanus*, but have recently been definitely located in a new genus, *Camallanus*, by Railliet and Henry (1915a). Though in habit hookworms by virtue of their persistent attachment to the intestinal wall, they do not possess a buccal capsule like all true hookworms; the valve-shaped lips form powerful lateral jaws that grasp the tissue, whereas the true hookworms possess a hollow cup into which the tissue is drawn by suction. Two species have been found in North American fresh-water fishes. The first is

*Camallanus ancylodirus* nov. spec. — The head (Fig. 4) is bent sharply ventrad, whence the specific name. The mature female is 25 mm. long by 0.56 mm. in maximum diameter. The caudal tip is bluntly conical, and 0.45 mm. in front of it lies the anus. The vulva is three-fifths of the length from the anterior end. The trident in the oral armature has three or rarely four prongs, irregular in form and 0.21 mm. long. The lips measure 0.142 to 0.168 mm. long by 0.18 to 0.187 mm. broad. The uterus, loaded with minute embryos, fills the entire body save at the extreme ends. The anterior region of the esophagus is 1.416 mm. long and 0.096 to 0.15 mm. broad; the posterior region measures 1.368 by 0.072 mm.

Mature males measure 15 mm. in length by 0.38 mm. in breadth at the center of the body. The lips are 0.126 mm. long by 0.12 mm. wide, and the trident arms 0.18 mm. long. The anus (Fig. 10) lies 0.156 mm. from the extreme tip. The caudal alae are 0.92 mm. long. The two spicules (Fig. 11) are nearly equal in length, but one is only half as heavy as the other. The posterior end is rolled in a half circle and the number of the caudal papillae could not be determined.

This parasite came from the intestine of the German carp at Fairport, Iowa, and is the first reported from that host on this continent. Evidently it is a native species that has accommodated itself to this new host, and its original host is as yet unknown. Instances are infrequent in which a host is known to have acquired an entirely new parasite.

*Camallanus oxycephalus* nov. spec. — Only females were found. Length up to 25 mm. and maximum breadth 0.27 mm. The anterior end (Fig. 3) is perfectly straight and much smaller than the preceding species. The body tapers regularly from the center about equally in both directions. A small but distinct constriction, or "neck," lies just behind the oral tridents and conforms to the curvature of the trident branches. The muscular esophagus is 0.47 mm. long and 0.085 mm. in diameter at the narrowest point, expanding near the end to 0.105 mm.; the second region of the esophagus is 0.57 mm. long, of nearly equal diameter throughout and as broad as the maximum breadth of the muscular esophagus. The vulva is located at the anterior margin of the middle third of the body. This species was taken from the intestine of the white bass and of the black crappie at Fairport, Iowa.

*Cucullanus* O. F. Müller 1777. — As Railliet and Henry have shown recently (1915a), the forms which rightly belong here are those to which the name *Dacnitis* Duj. 1845 has often been applied. They are characterized as follows:

Anterior end bent dorsad. Mouth elliptical with major axis dorso-ventral, bounded by two lateral valves recalling those of *Camallanus*. Esophagus pestle-shaped without bulb. Males without caudal alae; two equal spicules and an accessory piece. Preanal sucker without chitinous ring. Female with vulva near center. In alimentary canal of fish.

The genus was placed in the Heterakidae by Railliet and Henry chiefly because of the preanal sucker of the male. However, a ventral sucker is by no means confined to this family, and this one has no marginal ring such as is present in other Heterakidae; finally, the three lips of the Heterakidae are wanting. Accordingly, we have placed the genus in the Spiruroidea with which it agrees in the lateral valves at the mouth and the double esophagus, both characteristic of that group. The genus is the sole known representative of a family, the Cucullanidae, which differs from all other forms in the Spiruroidea through the possession of the ventral sucker in the male.

*Cucullanus clitellarius* nov. spec. — Body generally uniform in diameter, except for clitellar-like swelling 1.5 mm. from anterior tip (Fig. 5). Head bent dorsad 60 to 90 degrees. On each oral margin three papillae. Oral valves 0.45 by 0.32 mm. in female, and 0.33 by 0.24 mm. in male.

Males 10 to 11 mm. long by 0.38 mm. broad. Esophagus 1.45 mm. long and 0.12 to 0.22 mm. wide. Caudal region (Fig. 9) bent in a single turn. Ventral sucker 0.51 mm. anterior to anus, 0.1 mm. in diameter. From anus to tip of body 0.39 mm. Spicules 1.62 mm. long,

0.035 mm. broad, shaped like a gouge; accessory piece dagger-shaped, 0.06 long by 0.015 mm. broad. Two small papillae just in front of anus; four pairs of postanal papillae, of which two pairs are large, rounded, and only 0.012 mm. from extreme tip.

Females 12 to 17 mm. long, 0.5 mm. broad. Esophagus 1.6 mm. long and 0.13 to 0.32 mm. wide. Distance from anterior end to vulva from five-ninths to two-thirds total length. Uterus and ovary double. Ova 63 by 46 $\mu$ .

Parasitic in intestine of lake sturgeon (*Acipenser rubicundus*) in Lake St. Clair.

This genus has been heretofore the sole representative of its family, but among parasites in fresh-water fishes we have met another type that is sufficiently related to fall within the limits of the family, and yet cannot be brought within the limits of the same genus. To receive it a new genus has accordingly been created with the following characteristics:

*Dacnitoides* nov. gen.—Much like *Cucullanus*, except that head is not flexed and body is straight; spicules lack accessory piece, and only a single ovary is developed. A well developed intestinal cecum is present.

*Dacnitoides cotylophora* nov. spec.—Males 4 to 6 mm. long and 0.2 mm. broad. Mouth dorso-ventral, bounded by lateral valves. Cuticular ridge with three papillae at extreme anterior margin of each valve. Esophagus 0.5 to 0.6 mm. long, 0.06 to 0.12 mm. broad, distinctly divided into two regions; anterior region 0.2 mm. long. Intestine large, provided with dorsal cecum extending antieriad to junction between two regions of esophagus. Ventral sucker (Fig. 7) 0.41 mm in front of anus, which is 0.12 mm. from posterior tip. Spicules 0.89 mm. long and only 5 $\mu$  broad. Caudal papillae: one pair on anterior margin of sucker, four pairs between sucker and anus, four pairs of postanal papillae and one single median papilla immediately in front of anus.

Females 4 to 5.5 mm. long by 0.28 mm. in width at vulva; body distinctly short and heavy. Anterior end (Fig. 6) rounded, posterior end acutely pointed. Anus 0.14 mm. from posterior tip, with four slender spines halfway between. Vulva about five-eighths of total length from anterior end. Anterior and posterior uterine branches, but latter terminates blindly, and only former has an ovarian tube at end. Eggs measure 65 by 40 $\mu$ , and contain embryos in early cleavage stages.

This parasite was common at Lake St. Clair in the intestine of the yellow perch (*Perca flavescens*), and more rarely of the wall-eye (*Stizostedion vitreum*).

In that this species possesses an intestinal cecum it resembles the family of the Heterocheilidae which Railliet and Henry established

among the Ascaroidea on the basis of the development of such an organ. In other anatomical features it departs as widely from that family as it does from the Heterakidae.

An interesting parasite was taken from the intestine of the bowfin, or fresh-water dog-fish, *Amia calva*, both in Lake St. Clair, Michigan, and at Fairport, Iowa. It is of a very generalized character and hence difficult to define except in negative characters, or to locate in the system. While we are inclined to place it in the Spiruroidea under the family Spiruridae, we must confess that this decision is open to criticism, and it may have to be made the representative of a new family standing half way between the Ascaroidea and the Spiruroidea. It must certainly be made a new genus characterized as follows.

*Haplonema* nov. gen.—Body rather robust, but not large; anterior end bent or coiled, without lips or papillae, but with lateral alae (“wings”). No buccal capsule; esophagus muscular, without bulb, divided into two regions by partition near center. Posterior end of female straight, or slightly curved behind anus, with two minute papillae. Posterior end of male without bursa or alae, with two equal spicules of moderate length. Two pairs of preanal papillae and three pairs of postanals. Ovary laid in transverse loops ventral to intestine in both anterior and posterior regions. Uterus with anterior and posterior branches, vulva near center of body. Oviparous.

*Haplonema immutatum* nov. spec.—Males less frequent than females, measure about 9.5 mm. in length by 0.2 mm. in breadth anteriorly and 0.18 mm. posteriorly. Females about 15 mm. long by 0.31 mm. in maximum breadth in the anterior region. Vulva five-eighths of length from anterior tip.

Anterior end (Fig. 1) bent in a half circle with lateral cuticular folds extending back 2.5 or 3 mm. from anterior tip. Esophagus prominent, muscular, 0.65 mm. long in male and 0.8 mm. in female; width of esophagus, 0.06 mm. anteriorly and 0.1 mm. near its posterior end. Esophageal partition inconspicuous, near center of length; two regions alike in structure.

Spicules (Fig. 2) two, equal, flat, ribbon-like, 0.75 mm. long, by 0.02 mm. wide. Eggs abundant, with moderately thick, smooth shells; average size 65 by 45 $\mu$ .

The genus *Spinitectus* was established by Fourment in 1883 to contain parasites of fishes characterized by circles of retrorse spines on the posterior margins of transverse rings. To the four species known in Europe we add a new form common in some places here.

*Spinitectus gracilis* nov. spec.—Mature females 11 to 19 mm. long; body divided more or less distinctly into slender transparent anterior region about 6 mm. long and 0.066 mm. wide, and larger, darker, more

opaque posterior region about 12 mm. long and 0.14 mm. broad, crowded with internal organs, especially the uterus gorged with eggs. Tail abruptly conical, 0.096 mm. from anus to tip in female, only 0.066 in male. Vulva three-fourths length of body from anterior end, inconspicuous.

Spinous rings begin 0.12 mm. from anterior tip. First 6 to 8 rows more prominent than those later. Subsequent rows (up to 28 or 30) smaller, closer, with spines much lighter and shorter; last rows difficult to detect. Total about 130 rows. Rings about 0.03 mm. apart at anterior end, and contain 40 to 50 spines in each circle. Largest spines  $8\mu$  long, smallest less than half as long.

Male 12 mm. long by 0.042 mm. in diameter in anterior region and 0.75 mm. at widest point. Posterior end coiled in spiral with 2 to 3 turns. Narrow lateral alae 0.33 mm. long, near caudal tip, not supported by papillae or ribs. On ventral surface, 1 mm. anterior to anus a series of 4 to 8 longitudinal rows of small ridges, each about  $5\mu$  long and  $3\mu$  high. Spicules very heavy, longer scoop-shaped; shorter, arcuate, oblique, probably not protrusible.

Pharynx tubular or funnel-shaped, short. Muscular esophagus narrow, 0.33 mm. long in female and 0.25 mm. in male, no marked boundary between it and glandular region. Egg-filled uterus large. Ova 41 by  $24\mu$ , with thick transparent wall and without polar processes.

Some specimens 4 to 5 mm. long by 0.35 mm. broad have spines extending even to the anal region, 175 rows in all. From the vulva a broad vagina projects antieriad bearing at its inner end anterior and posterior uterine branches.

This parasite occurs in the alimentary canal of the black crappie, sheepshead, and white bass at Fairport, Iowa. In life it is transparent, and the spinous rings are very distinct. The worms are not attached to the wall, but lie free in the lumen of the gut. The spines are encased in masses of food particles.

Railliet and Henry include in this genus as *Spinitectus cristatus* a form described by Linton from the hake as *Filaria serrata*. They use his description of the male for the genus since Fourment found no males in his material. Our form differs from Linton's in the absence here of papillae he described and in the presence here of caudal alae he neither mentions nor figures.

A nematode parasitic in the perch in Lake St. Clair is assigned without hesitation to the genus *Ichthyonema*. The genus is closely related to *Dracunculus medinensis* of man. In Europe various species are abundant, and widely distributed, but one has never been reported before this in North America. Possibly some of the worms listed as "Filaria" from American fishes really belong here. The species we have does not agree with any known form and is designated as

*Ichthyonema cylindraceum* nov. spec.—Male unknown, probably minute. Mature female 100 mm. long, of nearly equal diameter (0.48 mm.) everywhere. No lips or papillae. Esophagus 1.09 mm. long, 0.066 mm. in diameter. Vulva and vagina atrophied, no vestiges discernible. Uterus crowded with undeveloped ova (i. e., female unimpregnated), ova almost spherical, measure 0.044 mm. in diameter.

In abdominal cavity of *Perca flavescens*, Lake St. Clair.

The worm was delicate, semitransparent, and very fragile owing to the thin body wall. The lateral lines are broad, light colored, and conspicuous. In Europe almost half of the females found are like our material, unimpregnated owing apparently to scarcity of males. This species is of great interest from its relationship to the Guinea Worm of man.

Among the Ascaridae, Railliet and Henry (1915) have grouped those forms having either an intestinal or an esophageal cecum into a single family, the Heterocheilidae. One form we have studied falls within this group, but cannot be placed in any of the genera found in it, hence a new genus is created to contain it characterized as follows:

*Hysterothylacium* nov. gen.—Body without anterior tunic, but with narrow lateral alae ("wings"). Lips three, not prominent. Esophagus long, slender, with terminal spherical bulb. Intestine with short simple cecum, arising from anterior end of intestine, directed posteriad. Males with two equal curved spicules, papillae(?). Females unknown.

*Hysterothylacium brachyurum* nov. spec.—Length of male 32 mm., maximum width just behind center of body, 0.66 mm. Lateral fin (Fig. 8) from base of lip to esophageal bulb or further; width one quarter the diameter of body.

Esophagus 3.1 mm. long, 0.1 to 0.13 mm. wide; bulb with three teeth, cecum 0.94 mm. long, 0.08 mm. wide. Spicules equal, 0.72 mm. long by 0.045 mm. wide. Pyriform sperm-vesicle prominent. In stomach of black bass, Lake St. Clair, Michigan.

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## EXPLANATION OF PLATE

Fig. 1.—*Haplonema immutatum*; head of female showing lateral fin fold, excretory pore, two regions of esophagus, esophageal valve, and intestine.  $\times 72$ .

Fig. 2.—*Haplonema immutatum*; tail of male showing spicules and papillae.  $\times 72$ .

Fig. 3.—*Camallanus oxycephalus*; head of female showing valves, trident, ring, and anterior region of esophagus.  $\times 72$ .

Fig. 4.—*Camallanus ancyloDIRUS*; head of female showing oral armature and two regions of esophagus.  $\times 22$ .

Fig. 5.—*Cucullanus clitellarius*; head of female showing valves, double esophagus, esophageal valve and intestine; also half of clitellar-like swelling.  $\times 20$ .

Fig. 6.—*DacnitoiDES cotylophora*; head of female, showing oral armature, esophageal regions, intestine, cecum, and anterior coils of ovary.  $\times 70$ .

Fig. 7.—*DacnitoiDES cotylophora*; tail of male, showing sucker, spicules and papillae.  $\times 70$ .

Fig. 8.—*Hysterothylacium brachyurum*; head of male showing lips, lateral fin-fold, esophagus, esophageal bulb, intestine, and cecum.  $\times 22$ .

Fig. 9.—*Cucullanus clitellarius*, tail of male, showing sucker, spicules and papillae.  $\times 22$ .

Fig. 10.—*Camallanus ancyloDIRUS*, tail of male showing spicules and papillae.  $\times 70$ .

Fig. 11.—*Camallanus ancyloDIRUS*, spicules of male.  $\times 110$ .

All reference lines in millimeters or tenths as indicated on plate.

# PLATE

